

WORKING PAPER

**REGIONAL DISPARITIES IN
CANADA: CHARACTERIZATION,
TRENDS AND LESSONS FOR
ECONOMIC POLICY**

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Industry Canada Industrie Canada

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**REGIONAL DISPARITIES IN
CANADA: CHARACTERIZATION,
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ECONOMIC POLICY**

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TABLE OF CONTENTS

1. INTRODUCTION	3
2. TWO CONCEPTS OF CONVERGENCE	7
3. CONVERGENCE ON EITHER SIDE OF THE 49TH PARALLEL	9
4. DECOMPOSITION OF VARIANCE OF PER CAPITA PRODUCTION DIFFERENCES BETWEEN CANADIAN PROVINCES AND BORDERING U.S. STATES	13
5. β CONVERGENCE, σ CONVERGENCE AND STEADY-STATE DISPARITIES IN WORKER PRODUCTIVITY	19
6. CONCLUSION: IMPLICATIONS FOR ECONOMIC POLICY	23
NOTES	25
BIBLIOGRAPHY	27
INDUSTRY CANADA RESEARCH PUBLICATIONS	29

1. INTRODUCTION

Since the early 1990s, regional studies have assumed considerable importance in economic research. Their renewed popularity is linked partly to the strong comeback of growth theory, which increasingly is the preferred tool for evaluating economic policies and blurs the traditional distinction between macro- and micro-economic frameworks for analysis. But regional studies also owe their current popularity to the fact that many growth problems at the end of the 20th century are regional in impact, for example, the collapse of the communist bloc in Eastern Europe, German reunification, European integration and the emergence of trading blocs.

Starting with studies by Barro and Sala-i-Martin (1991, 1992 and 1995) and Mankiw, Romer and Weil (1992), the question of convergence — that is, the catching up of poor economies with rich economies, whether at the regional or international level — has received considerable attention from researchers.¹ Significant progress has been made in dynamic modelling under the neoclassical model and endogenous growth models. Recent analyses stress features such as the dynamics of the adjustment of physical and human capital, migrations, economic and political integration, the stability and effectiveness of public institutions, economic policy and the spread of technology. In Canada, several empirical studies — Helliwell and Chung (1991), Helliwell (1994), Lefebvre (1994), Coulombe and Lee (1993, 1995 and 1996) and Lee and Coulombe (1995) — have made it possible to draw up a statistical picture of the situation showing that regional disparities in per capita income and production, as well as in worker productivity, have tended to diminish since the Second World War. This movement toward convergence, however, has slowed down since the late 1970s, a phenomenon that can also be seen within all the industrialized countries (Sala-i-Martin, 1995).

As we shall show later, in 1950 regional disparities in per capita production and income were far greater within Canada than in the 12 U.S. states bordering on Canada. For the present study, these bordering U.S. states — that is, Washington, Idaho, Montana, North Dakota, Minnesota, Michigan, Ohio, Pennsylvania, New York, Vermont, New Hampshire and Maine — together serve as a control group for purposes of comparison since they closely resemble adjacent regions of Canada in terms of economic geography. (The Yukon, the Northwest Territories and Alaska are excluded from the study.) In 1950, the relative dispersion index of per capita personal income was almost three times higher in the different regions of Canada than what could then (and can still) be observed in the case of the bordering U.S. states. The deviation has narrowed since then because the convergence observed north of the 49th parallel in the postwar years had the effect of bringing closer per capita income disparity levels on both sides of the border. Nevertheless, there are still large disparities between the different regions of Canada in terms of per capita production. Referring to a relative index of per capita production differences for the most recent regional data, we shall show that regional disparities in Canada today are nearly twice as great as in the bordering U.S. states. Part of the per capita income convergence between Canadian regions can thus be attributed to inter-regional redistribution via “fiscal federalism” and the taxation system.

The persistence of large regional disparities creates major problems for the management of economic policy in a federation such as Canada: its central government has always pursued regional development policies and, since the Second World War, it has set up a vast structure for inter-regional redistribution. More recently, in 1987 Ottawa established agencies to plan and promote regional economic development in the Atlantic provinces (Atlantic Canada Opportunities Agency), Northern Ontario (FedNor) and the Western provinces (Western Economic Diversification), and it did the same for Quebec (Federal Office of Regional Development — Québec) in 1991. The ability to support these programs and policies is directly linked with the persistence of regional economic

disparities. This question is especially pertinent at a time when government faces growing financial constraints.

The aim of the present study is to examine the history of Canada's regional disparities through empirical analysis in line with the new wave of studies focusing on convergence and economic growth. The empirical part of the study will be conducted in two phases. First we shall undertake a comparative analysis of the history of regional disparities in per capita production, in both Canada and the bordering U.S. states. After identifying certain statistical facts, we shall then examine three components — the dispersion of productivity, the dispersion of employment rates (via unemployment rates) and the dispersion of the participation rate — in order to study the history of the deviation between Canada and the bordering U.S. states with respect to dispersion of per capita production. This decomposition will be revealing to the extent that the neoclassical adjustment based on the law of diminishing returns and the accumulation (and mobility) of physical and human capital results in a convergence of the productivity of factors. The two other determinants of dispersion of per capita production (dispersion of the unemployment rate and of the participation rate) are linked to the functioning of the labour market and household decisions on the balance to be struck between work and recreation.

In the second phase of the empirical analysis, we make use of a method for estimating β convergence based on a sample group–type process recently developed by Coulombe and Day (1996) to assess the speed of convergence of productivity and other economic indicators between Canada's regions. This method builds on that used by Coulombe and Lee (1993, 1995) and Lee and Coulombe (1995) in their studies on regional convergence. Compared with the conventional approach, which is based on estimates by transversal section (see Barro and Sala-i-Martin, for example), the method proposed here allows better use to be made of all the data concerning regional growth profiles since it integrates as well the information resulting from the yearly movement of series of regional economic indicators. By integrating data on longitudinal and transversal sections, the sample group method can be viewed as an attempt to modify the approach of Barro and Sala-i-Martin to take into account the criticism of Quah (1993).² Sample group estimation offers the advantage of producing estimates of the speed of β convergence; combined with estimate residuals, these allow us to create a dynamic simulation of movements in the variance of regional disparities (σ convergence). Dynamic analysis highlights the concept of the stationary level of variance, i.e., the long-term balance of regional disparities. The steady-state disparity is determined by the interaction between the strength of the convergence resulting from faster accumulation of physical and human capital in poor regions and, on the other hand, the variance in regional disturbances forcing regional economies to temporarily stray from the path of convergence leading them toward long-term equilibrium.

The proposed analysis goes beyond statistical representation since the level of decomposition, its predictive nature, the theoretical basis and the dynamic simulations are such as to clarify the making of decisions about regional development policies. For example, from the movement of differences in worker productivity in relation to its steady state and to differences in the control group (the bordering U.S. states), we can gain insight into the subject of the dynamics of physical and human capital accumulation and the operation of market forces. It can nevertheless happen that the political and institutional context undermines convergence of worker productivity. In this case, regional development policies should therefore target the mobility of physical and human capital and the spread of technology. Further, if productivity differences remain excessively large, it can happen that they are eliminated automatically, at least in part, since the neoclassical

convergence mechanism will start functioning once the hindrances to physical/human capital mobility and to the spread of technology will have disappeared or lost their importance. If per capita production differences between Canada and the United States are related mainly to differences in the unemployment and participation rates, regional development policies should instead target worker mobility and the balancing of work and recreation. Last, through the analysis of variances and co-variances, we can recognize the interaction of different factors and offer an interpretation suitable for guiding regional development actions.

The balance of the study is structured as follows: First, the next section describes the concepts of β and σ convergence as well as the theoretical relationship that exists between the two within the framework of the hypothesis of unconditional convergence. It should be noted that this relationship underlies the simulation undertaken later in the study. The following section presents statistical data and compares movements in regional disparities in production and per capita income in Canada and the bordering U.S. states. This comparative analysis is then supported by decomposition of the per capita production variance in terms of the variance and co-variances of its three components (productivity, unemployment rate and participation rate). The study next turns to the sample group-type econometric approach, which is used to estimate β convergence, and we explain the links between the estimate of parameter β , the estimate residual and the concept of σ convergence. The estimate results for β and the stationary level of variance of regional disparities are presented and analysed. The dynamic simulation of the path of productivity variance is compared with the path observed. The section presenting conclusions highlights the implications of our analysis for regional development policy issues in Canada.

2. TWO CONCEPTS OF CONVERGENCE

From a general viewpoint, the concept of β convergence refers to the speed at which economies tend to approach their stationary equilibrium, that is, a regime of balanced growth. As shown by Barro and Sala-i-Martin (1995), this concept can be associated with different versions of the neoclassical growth model: Solow (1956) and Swan (1956), for example, make use of the constant savings rate; Ramsey (1928), Cass (1965) and Koopmans (1965) make use of cross-time optimization; Mankiw, Romer and Weil (1992) use human capital accumulation; and Cohen and Sachs (1986) use the concept of open economies with indebtedness constraint. The phenomenon of convergence is explained by the fact that the return from the accumulation of physical and human capital is subject to the law of diminishing returns. In proceeding with a log-linear approximation in the neighbourhood of a balanced growth regime, Barro and Sala-i-Martin (1995, Appendix 2A) show, within the context of the neoclassical growth model with cross-time optimization (endogenous savings rate), that the per capita production logarithm for economy i , in effective labour units at time t , \hat{y}_{it} is a weighted average of its initial value at time 0 and its stationary value \hat{y}_i^* :

$$\hat{y}_{it} = e^{-\beta t} \hat{y}_{i0} + (1 - e^{-\beta t}) \hat{y}_i^* \quad (1)$$

β is the speed of convergence of \hat{y}_{it} toward its stationary value. Equation 1 can be expressed as a relation between y_{it} , per capita production at time t , y_{it-1} , and u_{it} an error term that captures the effect of temporary disturbances on y_{it} :

$$y_{it} = x + (1 - e^{-\beta}) [\hat{y}_i^* + x(t-1)] + e^{-\beta} y_{i,t-1} + u_{it} \quad (2)$$

Here x (which measures neutral technical progress in accordance with Harrod, integrated with the work force and population growth) is the growth rate of effective labour units and of the economy in stationary equilibrium. During the transition period, the phenomenon of convergence is explained by the fact that an economy in which the per capita production level is lower than its steady-state level will have a growth rate higher than its underlying growth rate x . As the economy approaches its stationary level, its growth rate converges asymptotically toward x . Equations 1 and 2 represent the concept of *conditional convergence* in the sense that the per capita production of unit i and its growth rate at time t , which are changing parameters, converge toward their stationary level (y^* and x).

As for the concept of *unconditional convergence*, it refers to the case in which all economies converge toward the same stationary equilibrium. The convergence hypothesis thus assumes that the economy initially having the lowest per capita production level will experience a faster growth rate in the course of its catching-up period. It should, nevertheless, be noted that the neoclassical model, as with all models providing the theoretical basis for equations 1 and 2, predicts not unconditional but conditional convergence. The hypothesis of unconditional convergence has, however, been verified empirically in a number of studies for relatively similar economies (e.g., member countries of the Organization for Economic Co-operation and Development, U.S. states, European regions, Japanese prefectures and Canadian provinces). The estimating method followed by Barro and Sala-i-Martin (1991, 1992) involves using a variant of equation 2 for a non-linear

regression by transversal section of a group of N (for $i = 1, \dots, N$) national or regional economies. To this end the term $y_{i,t-1}$ is removed from both sides of equation 2, which is rewritten for a period of T years:

$$\frac{y_{iT} - y_{i0}}{T} = a_i - \frac{(1 - e^{-\beta T})}{T} y_{i0} + u_{i0,T} \quad (3)$$

where $a_i = x + [(1 - e^{-\beta T})/T] y_i^*$. The term on the left side of the equation is the average growth rate of y_i during the period 0- T . The hypothesis of unconditional convergence involves assuming that term a_i is constant between the economic units i . Equation 3 can be modified to introduce variables that determine stationary per capita production levels (savings rate, political institutions, etc.) in order to test the hypothesis of conditional convergence.

For a group of N economic units having identical parameters of stationary equilibrium, equation 2 implies that the variance of y_{it} and σ_t^2 will follow a self-regressing non-linear process determined by the speed of β convergence and the variance of the estimate residual of equation 2 — σ_{ut}^2 — which is assumed to be constant in time:

$$\sigma_t^2 = e^{-2\beta} \sigma_{t-1}^2 + \sigma_{ut}^2 \quad (4)$$

if the co-variance between $y_{i,t-1}$ and u_{it} is set aside. If β is positive and the initial dispersion level is higher than its long-term equilibrium, the variance of y_{it} will tend to decrease and to approach asymptotically its stationary level σ^{2*} :

$$\sigma^{2*} = \frac{\sigma_{ut}^2}{1 - e^{-2\beta}} \quad (5)$$

By combining equations 4 and 5, we obtain equation 6, which describes movements of the variance of y_{it} in terms of parameter β , the initial dispersion level σ_0^2 and the stationary level of variance σ^{2*} :

$$\sigma_t^2 = \sigma^{2*} + (1 - e^{-2\beta t})(\sigma_0^2 - \sigma^{2*}) \quad (6)$$

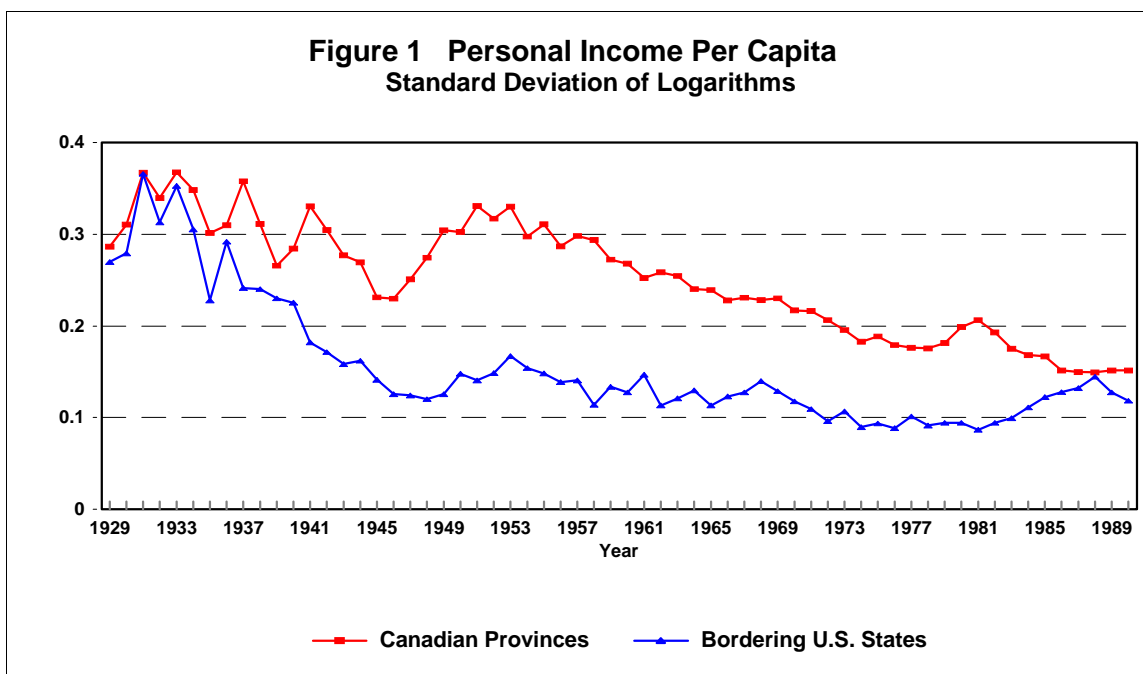
If the dispersion index is higher than its stationary level and the speed of β convergence is positive, the dispersion index will exhibit a tendency to decrease over time. We then observe σ convergence.

3. CONVERGENCE ON EITHER SIDE OF THE 49TH PARALLEL

This section presents a comparative analysis of movements in regional disparities of per capita production and income and of worker productivity in Canada and the 12 bordering U.S. states. We use a data base with yearly information going back to 1929 in some cases, for different economic and demographic indicators concerning the 12 U.S. states and the 10 provinces of Canada. All the data were generated by official Canadian and U.S. statistics agencies. The data base was constructed in winter 1996 at the University of Ottawa by Serge Coulombe and Kathleen Day as part of their research work on regional economies.

Figure 1 shows long-term trends toward σ convergence for the Canadian provinces and bordering U.S. states. The figure highlights certain statistical facts, most of which have been described in recent literature:

- Per capita income dispersion indexes in Canada exhibit a tendency to decline in the long term. Since the chronological series is marked by a serious structural discontinuity between 1945 and 1950, it is difficult to determine exactly when the phenomenon of σ convergence occurred. Helliwell (1994) maintains that convergence has been observed over the entire period from 1929 to 1990, while Coulombe and Lee (1996) believe that it began in 1949 and ended around the mid-1970s.
- The process of σ convergence seems to have come to a halt from the late 1970s for regional economies on either side of the 49th parallel. Since that time, the per capita income dispersion index has increased for bordering U.S. states but it has remained almost constant for Canadian provinces. Barro and Sala-i-Martin (1995, p. 393) note the interruption in the process of σ convergence in the U.S. states, and they attribute it to the policies of President Reagan. However, Sala-i-Martin (1995) comments that the phenomenon is common to all the industrialized countries and that a different



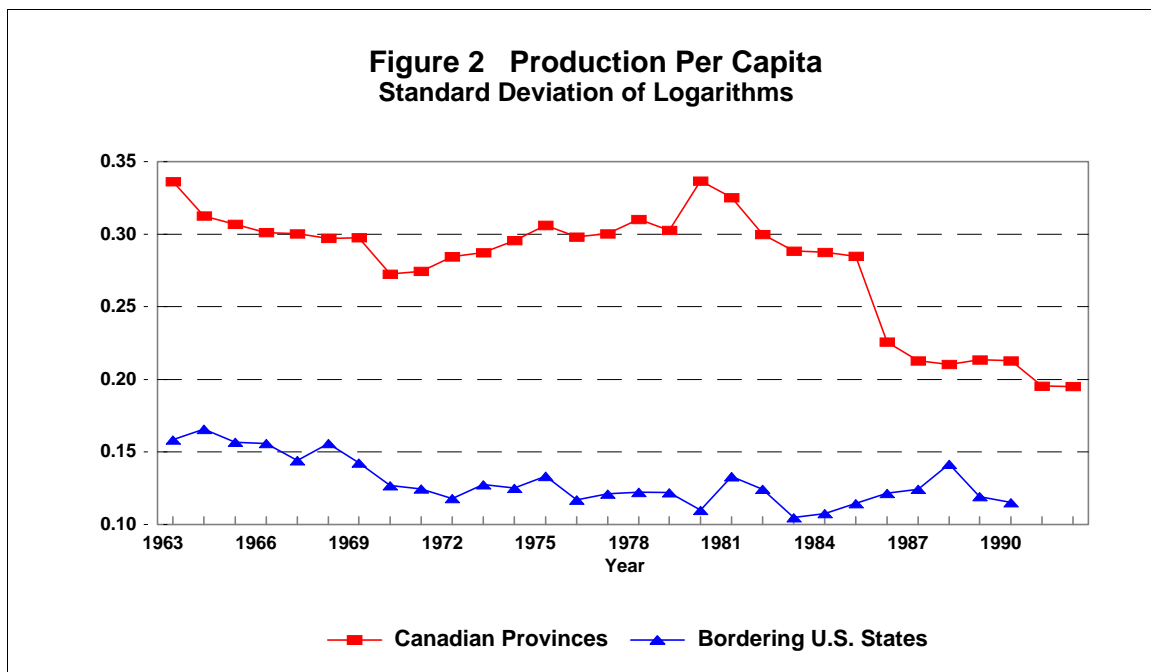
explanation is required; he suggests the intensification of technological upheaval. Another explanation for the slowdown in σ convergence within Canada will be considered later in this study, namely, that dispersion indexes may have attained a steady-state level.

- Throughout the period, per capita income disparities were greater in Canada than between the bordering U.S. states.
- The per capita income dispersion index between bordering U.S. states has not changed much since 1944.

As shown by Barro and Sala-i-Martin (1995, pp. 389–91), per capita income in southern U.S. states, which were among the poorest states in 1880, rose much more rapidly than the national average between 1880 and 1990. This North–South convergence is one of the distinguishing features in the history of regional disparities in the United States.

The bordering U.S. states can be regarded as a control group for studies of the Canadian economy since they share many characteristics with the adjacent provinces — abundant natural resources, the location of the industrial heartland near the Great Lakes — and since Canada’s population and economic activity are concentrated near the U.S. border. Given these similarities, it is surprising to note that bordering U.S. states converged far more rapidly than the Canadian provinces, and that their level of per capita income disparities in 1945 was lower than the level in Canada in 1990.

As the Canadian provinces and U.S. states are open economies, from the viewpoint of convergence it may be important to make a distinction between an indicator of per capita income (or of national product) and an indicator of a state’s or province’s domestic production. It may happen that part of a region’s capital stock belongs to residents of a different region and that some people work in another province (or another state) than the one in which they reside. Barro and Sala-i-



Martin (1992) have shown that the distinction between concepts of income and domestic production have scarcely any practical importance for questions relating to convergence between U.S. states. In contrast, Coulombe and Lee (1995) have shown that it is highly important to make such a distinction concerning Canadian regions, given the scope of inter-regional redistribution carried out through fiscal federalism. As per capita income is an indicator that encompasses all redistribution measures, we have chosen domestic production as an economic indicator for the rest of this analysis. In the Canadian context, the interprovincial dispersion of domestic per capita production is an indicator of the demand for inter-regional redistribution, which must be carried out through fiscal federalism.

Movements in the standard deviation of logarithm (the coefficient of variation) for per capita production between the Canadian provinces and bordering U.S. states is shown in Figure 2.³ The main conclusion to be drawn from this figure is that, **despite the regional convergence that took place in Canada over the postwar period, inter-regional disparities in per capita production observed in the early 1990s remained much higher than they were in the bordering U.S. states.** The standard deviation of logarithm for per capita production in Canada in 1990 was twice as high as that recorded in bordering U.S. states. The following section presents features of an analysis that might explain the differing movements in per capita production disparities on either side of the 49th parallel.

4. DECOMPOSITION OF VARIANCE OF PER CAPITA PRODUCTION DIFFERENCES BETWEEN CANADIAN PROVINCES AND BORDERING U.S. STATES

The existing deviation between the Canadian provinces and bordering U.S. states with regard to regional disparities in per capita production is not a passing phenomenon. It is evident throughout the observation period (1963–90), a significant deviation between the two geographic groupings with regard to dispersion indexes of per capita production. In this section, we undertake a decomposition of the variance in per capita production differences between the Canadian provinces and bordering U.S. states. This process will highlight certain features helping us better understand the problem posed by the existence of major regional disparities in Canada. It may be that the act of taking into account these features can help guide Canada's economic policy.

If Y is production, P population, W employment and A participating workers, per capita production can be decomposed into three components: worker productivity (Y/W), the employment rate ($W/A = 1$ minus the unemployment rate) and the participation rate (A/P), to give the following equation:

$$\frac{Y}{P} = \frac{Y}{W} \cdot \frac{W}{A} \cdot \frac{A}{P} \quad (7)$$

While the three components of per capita production are interlinked, the changes in each of them may be explained for each of the regions by specific economic and institutional factors. For example, the dynamic process of neoclassical convergence assumes the gradual elimination of disparities in worker productivity through the interaction of the phenomenon of accumulation of physical capital and the law of diminishing returns. If major differences persist in worker productivity between the regions of a single country, they would be attributable to delayed development. As for major inter-regional differences in the employment rate (unemployment rate) or the long-term participation rate, they would be explained by considerations relative to labour market functioning and adjustments, the balance between work and recreation, and households' choice of geographic location. The interactions between these three factors can also help explain to a very large degree the inter-regional differences in per capita production. For example, in a region with harsh climate, infested with mosquitoes, without public infrastructure, where there is a construction site for a hydro-electric dam, we would expect that the per capita production is very high: worker productivity, the employment rate and the participation rate should, in principle, be high there since unemployed and non-participating persons are not interested in staying in so unwelcoming a region. On the other hand, we must expect that per capita production is low in a region that has lost its main source of economic development but where the infrastructure and public services are partly subsidized by transfer payments from the central government, where the cost of living is reasonable and the natural environment is pleasant.

In Figures 3, 4 and 5, we present changes in the dispersion index of per capita production in the case of each of the three components for the Canadian provinces and bordering U.S. states. The lack of data for certain years forces us to limit the observation period to the years from 1966 to 1990. Figure 3 also shows changes in the dispersion indicator of worker productivity for the Canadian provinces excluding Alberta (CPEXA). It can be seen that changes in this index for the

provinces taken together differ from changes in the CPEXA index starting from 1973. In that year began a period during which changes in production per worker in Alberta were affected by skyrocketing oil prices.

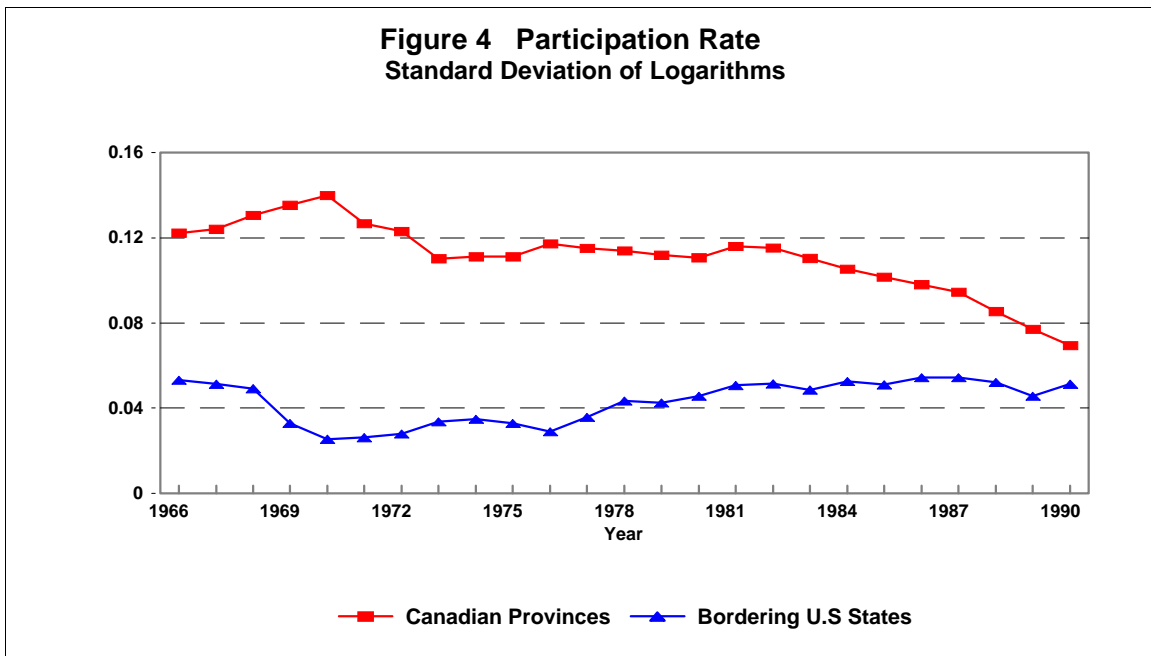
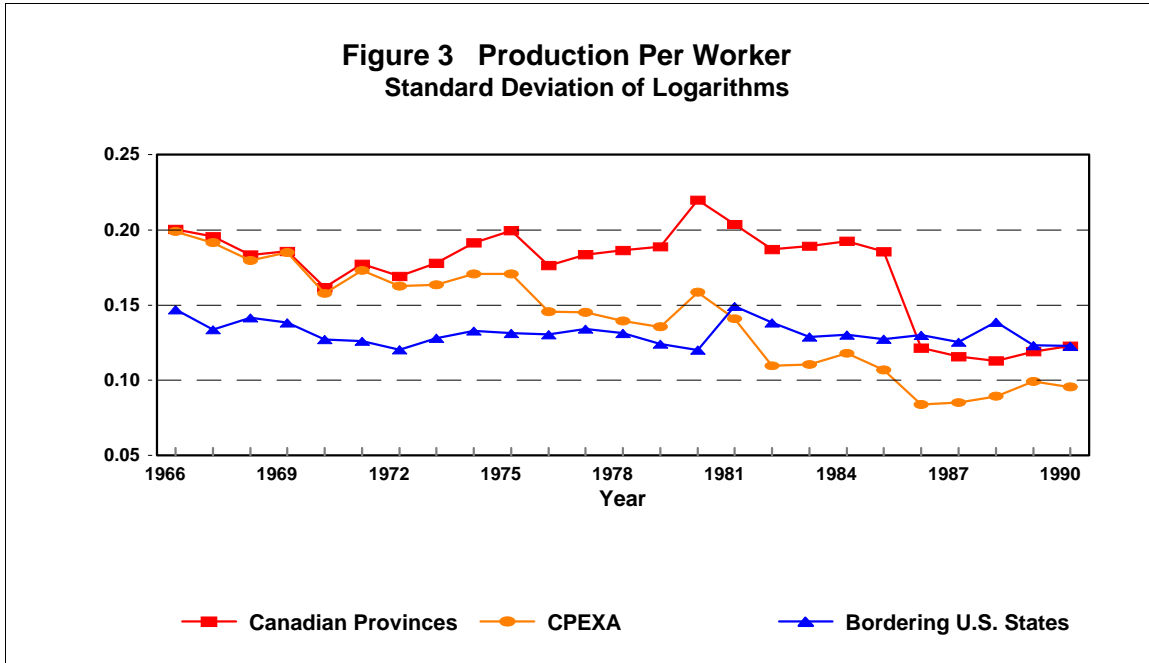
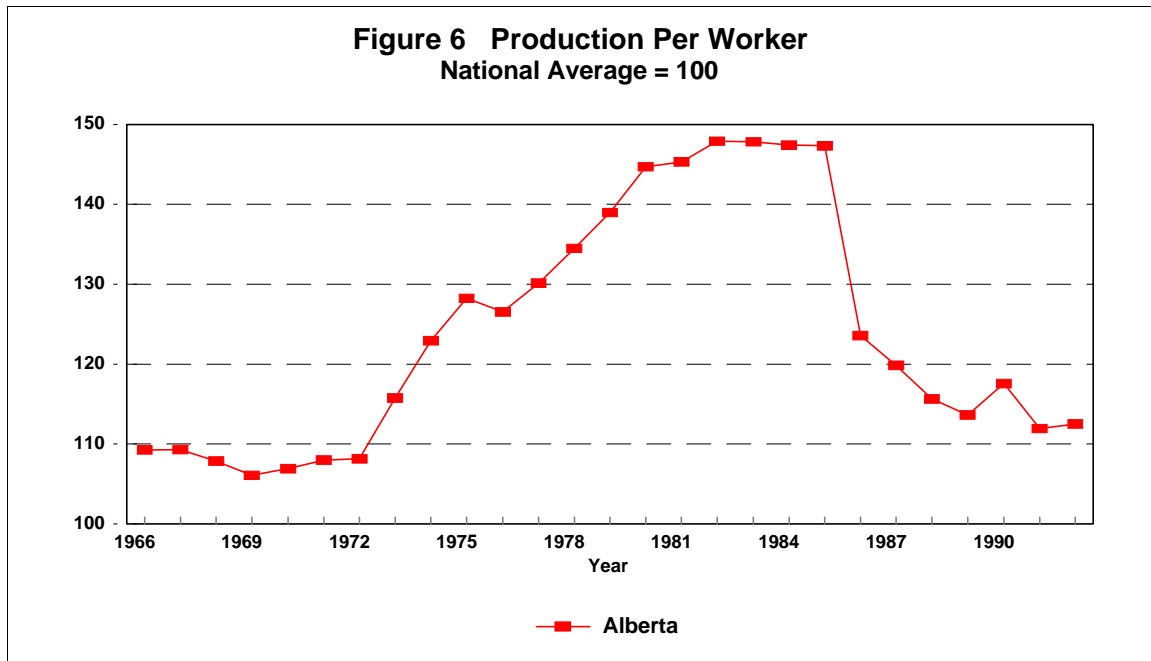
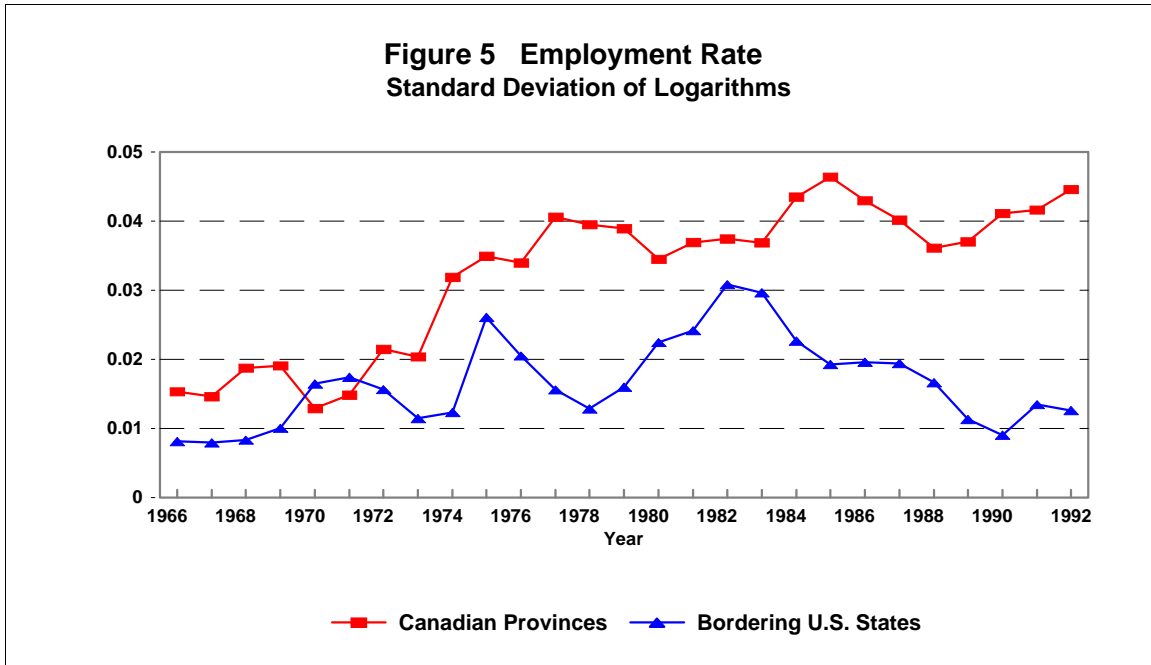


Figure 6 illustrates changes in production by workers in Alberta, expressed in terms of the national average. Between 1972 and 1985, the rise in the relative price of oil caused Alberta's relative productivity to rise from 110 to 150 per cent of the national average. As Alberta was the richest Canadian province during a good part of the observation period, the change in worker



productivity had a very significant impact on the standard deviation of this indicator for Canadian provinces as a whole.⁴ It also seemed to us desirable to exclude Alberta from the part of our analysis making a comparison with bordering U.S. states, since none of these was affected by oil prices as much as Alberta. Bordering U.S. states thus offer a suitable basis for comparison with Canadian provinces, so long as Alberta is excluded from the analysis.

An important point emerges from Figure 3: the dispersion index of CPEXA worker productivity, which was about 25 per cent higher than equivalent indexes for bordering U.S. states at the beginning of the period of analysis, converged toward levels of the U.S. states between 1966 and the late 1970s. Further, if we set aside this movement of convergence, we can see that, from 1972 until the mid-1980s, changes in worker productivity in Alberta explain most of the deviation between Canadian and U.S. dispersion indexes. Throughout the period, the dispersion indexes of the bordering U.S. states are more or less the same and relatively constant. This result indicates that **the neoclassical convergence process helped reduce regional disparities in Canada, since in the early 1980s the dispersion index of worker productivity finally reached a level relatively comparable to that already observed for some time in the case of bordering U.S. states.**

From Figure 4 we can see that the dispersion index of the participation rate in Canadian provinces fell throughout the period but remained higher than indexes for the bordering U.S. states. Figure 5 shows that, toward the mid-1970s, a significant deviation occurred between the Canadian provinces and the bordering U.S. states with regard to the dispersion index of employment rates.⁵

It is not possible to draw up a picture of the entire situation from a comparison of variances in the three components of per capita production in the Canadian provinces and U.S. states because, as the following analysis will show, a consideration of co-variances reveals certain features crucial to the analysis. The variance of Y/P can be decomposed as follows:

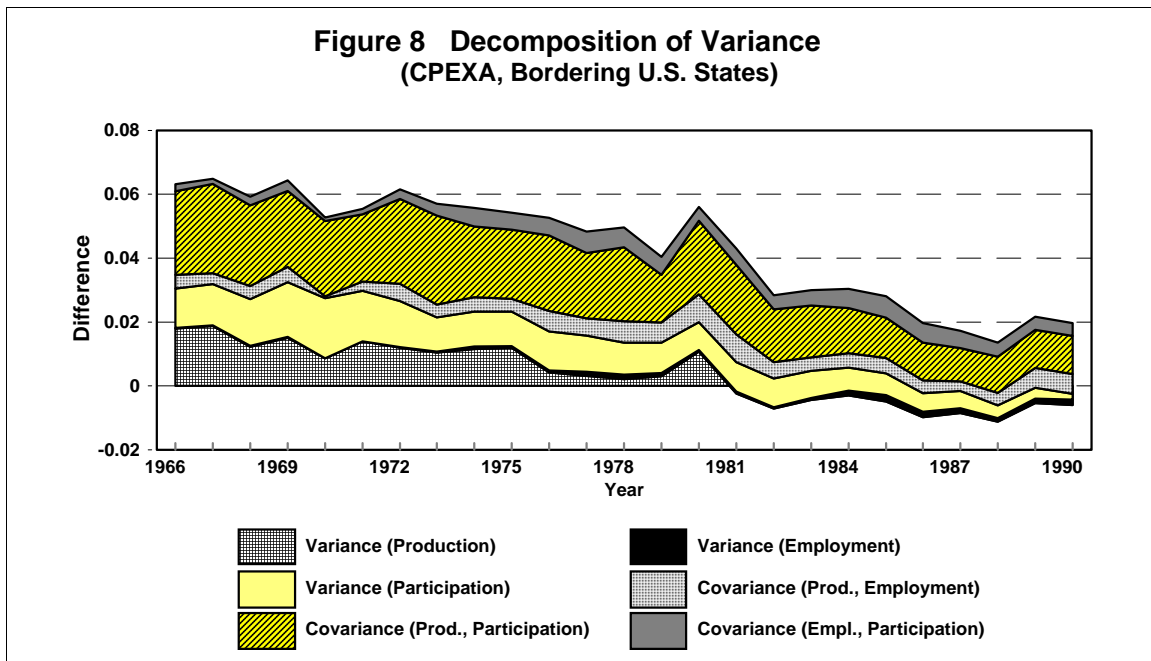
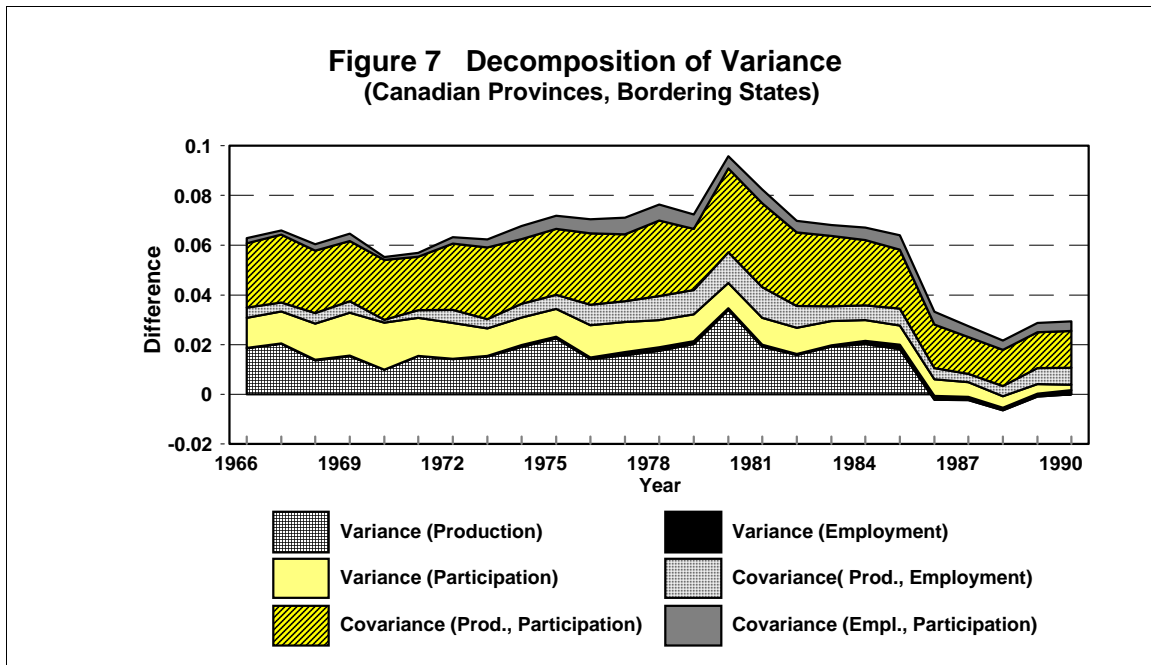
$$\begin{aligned} \text{var}(Y/P) = & \text{var}(Y/W) + \text{var}(W/A) + \text{var}(A/P) + 2\text{covar}(Y/W, W/A) + \dots \\ & + 2\text{covar}(Y/W, A/P) + 2\text{covar}(W/A, A/P) \end{aligned} \quad (8)$$

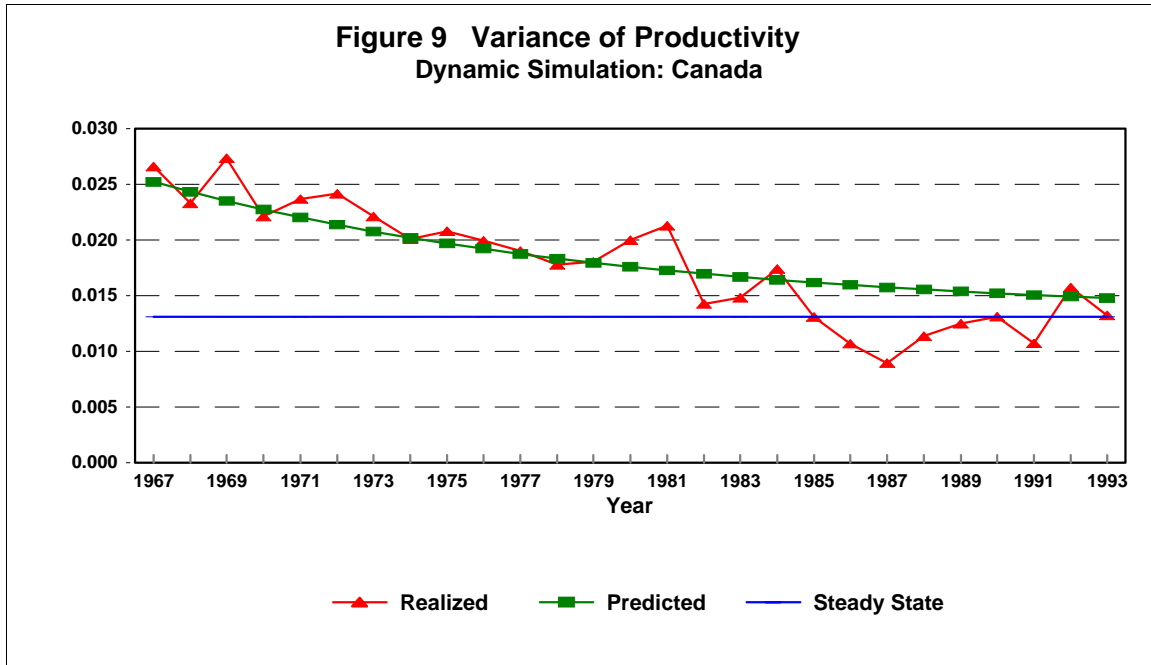
We have used this decomposition to explain the deviation between the variance in per capita production in the Canadian provinces and that in the bordering U.S. states. Figures 7 and 8 present changes in the decomposition between 1966 and 1990, with Alberta being excluded in Figure 8 (CPEXA).

The only significant difference between Figures 7 and 8 lies in changes in the variance of worker productivity. By excluding Alberta, we can observe a gradual decrease between 1966 and 1980 in the component of the deviation of per capita production, which is directly attributable to the variance of worker productivity, as can be seen from Figure 3. Since the early 1980s, the direct effect of this factor on the per capita production deviation (Figure 9) is even slightly negative.

By analysing Figures 7 and 8, we can also see the relative significance of co-variances. While the direct effect of variances in productivity and in participation rate declined over the period of analysis, the effect of the three co-variances remained almost constant; as a result, toward the end of the period, by themselves they accounted for the major part of the deviation in per capita production between the Canadian provinces and bordering U.S. states. This analysis shows that there persisted much greater inter-regional differences in per capita production between the Canadian provinces than between the U.S. states because **in the Canadian provinces, in contrast to the**

situation in bordering U.S. states, the employment rate and the participation rate are much lower where worker productivity is low, but higher where productivity is high. As was emphasized earlier, this result seems to indicate that the problem of regional disparities in Canada during the 1990s does not arise from a lack of convergence of the productivity of factors, which





would be attributable to a problem in physical/human capital adjustment; instead it arises from factors such as the functioning of labour markets, the balance between work and recreation, and households' choices of geographic location. In the bordering U.S. states with low productivity, the employment rate and participation rate are relatively high, indicating that Americans choose to live in these regions only to the extent that they can work there. In contrast, many Canadians chose to live in provinces with low productivity even though they cannot work there.

5. β CONVERGENCE, σ CONVERGENCE AND STEADY-STATE DISPARITIES IN WORKER PRODUCTIVITY⁶

In this section we estimate the speed of β convergence of per capita production and worker productivity for the 10 Canadian provinces for the years 1967 to 1993. Data on provincial production are determined with the help of implicit deflators of provincial production estimated by the Conference Board of Canada. The hypothesis of unconditional convergence is tested by means of a sample group-type regression by longitudinal section (annual data) and transversal section (for the 10 provinces), based on a modification of equation 2.

The hypothesis of unconditional convergence allows us to assume that the term $x + (1 - e^{-\beta})[\hat{y}_i^* + x(t-1)]$ in equation 2 is constant for the 10 Canadian provinces. In a sample group-type regression by longitudinal section, we must however take into account the statistical fact that the underlying rate of productivity growth (term x) fell significantly during the period of analysis from the late 1970s. We can then take out the trend from the first term on the right side of equation 2, removing M_t (the average of y_{it}) from both sides of the same equation. In regressions by annual section, this method also has the advantage of taking out national cyclical variations from regional annual growth rates. M_t , the logarithmic mean of y_{it} , can be represented by the following equation:

$$M_t = \frac{1}{10} \sum_{i=0}^{10} y_{it} = \frac{1}{10} \sum_{i=1}^{10} (x + [1 - e^{-\beta}][\hat{y}_i^* + x(t-1)] + e^{-\beta} y_{i,t-1} + u_{it}) \quad (9)$$

As x_i and \hat{y}_i^* are constant for all values of i , changes to M_t can be represented in terms of M_{t-1} as follows:

$$M_t = x + (1 - e^{-\beta})[\hat{y}_i^* + x(t-1)] + e^{-\beta} M_{t-1} + \sum_{i=1}^{10} u_{it} \quad (10)$$

where v_t is the average value of u_{it} . By removing the terms on left and right sides of equation 9 from the terms on left and right sides of equation 2, we obtain the following equation:

$$y_{it} - M_t = e^{-\beta}(y_{i,t-1} - M_{t-1}) + (u_{it} + v_t) \quad (11)$$

The constant term for the provinces (although variable in time) disappears when the level of per capita GDP in province i , divided by the national average for period t (the term on the left side of equation 10, since the variables are logarithms) is expressed in terms of the same ratio in the preceding period.

The speed of β convergence of production per worker between the Canadian provinces has been estimated through a sample group method based on equation 10 for $i = 1, \dots, 10$ and the period $t = 1967, \dots, 1993$. The results of the two regressions are presented in Table 1.⁷ The first regression draws on chronological series relative to the 10 Canadian provinces. The second regression excludes observations relative to Alberta, thereby allowing us to remove from the analysis the major sectoral upheaval related to oil price changes by estimating parameter β for the 9 other provinces and comparing the results with those obtained for the observations overall.

Table 1
Results of sample group–type estimates, β convergence of production per worker in the Canadian provinces (1967–93) and dynamic simulation of σ convergence, regional production deflators

	10 provinces	9 provinces (excl. Alberta)
β	0.038	0.070
Ratio <i>t</i>	2.62	3.48
Half-life (in years)	18	10
<i>N</i>	243	216
σ*	0.1145	0.087
R ² (σ)	0.8048	0.83

The estimates of the speed of β convergence for the 10 Canadian provinces and the half-life of convergence presented in Table 1 are comparable to those obtained by Coulombe and Lee (1995) and Lee and Coulombe (1995), using a slightly different method.⁸ The estimated speed of convergence is generally more rapid than that resulting from estimates as performed by Barro and Sala-i-Martin, which are based solely on transversal sections and stand mostly between 2 and 2.5 per cent for regional data.

Coulombe and Day (1996) use estimates of β and the regression residual to produce a dynamic simulation of the standard deviation of logarithms of worker productivity (σ convergence) with the help of equations 4 to 6. The results of the dynamic simulation are presented in graph form in Figures 1 and 2. The steady state of σ* disparities predicted by the dynamic simulation and the R² in this simulation⁹ are presented for both cases (Canadian provinces, and Canadian provinces minus Alberta) in Table 1.

The first point emerging from the analysis is that the results of the two simulations (with and without Alberta) allow us to assume that regional disparities in worker productivity would have reached a long-term equilibrium in the early 1980s. Thus, **the slowdown in convergence of regional disparities in Canada observed since the early 1980s could be explained by the fact that the level of regional disparities in worker productivity reached a point of equilibrium.** This analysis allows us to assume that it would perhaps be vain to hope that the neoclassical convergence mechanism will lead to further decreases in differences in productivity and per capita production in Canada in the future. Coulombe and Day (1996) also show that we can obtain estimates of steady-state regional disparities in productivity that are not very different from those observed for some 10 years when we make use of the classical estimating formula employed by Barro and Sala-i-Martin. Last, it should be noted that, if we compare the results of the two estimates presented in Table 1, exclusion of Alberta from the analysis has the effect of lowering the value of the steady state of regional disparities in productivity and significantly increasing the speed of convergence.

This process shows that the estimate of the speed of β convergence with the help of a sample group formula based on use of annual data yields results closely in accord with the theoretical

framework, since there is only a slight deviation between the path of changes in the variance of productivity emerging from the dynamic simulation and what can be observed from the actual situation. In both cases, the R^2 in the simulation exceeds 80 per cent. Comparison of the two estimates shows that the results are relatively reliable: the ability of the dynamic simulation model to accurately reflect historical changes and to predict a steady state in regional disparities does not lessen when we include or exclude a region such as Alberta.

6. CONCLUSION: IMPLICATIONS FOR ECONOMIC POLICY

The results of the present study on changes in regional disparities in Canada converge toward a guiding line. They allow us to assume that, with regard to growth dynamics, market forces have finally played their part to eliminate, as far as possible, regional disparities in worker productivity over the last 35 years. On the empirical level, the catching-up phenomenon that has been observed in Canada closely resembles the process predicted by neoclassical convergence theory. The process results from the dynamics of physical/human capital accumulation and from the law of diminishing returns, with capital tending to accumulate more rapidly in economies where it is relatively more rare. This observation seems quite reliable since it is based on results obtained through two different methods. On the one hand, the dispersion index of worker productivity has converged over the last three decades toward the level observed for the bordering U.S. states. This level of disparity in productivity is relatively low since it assumes that standard deviations with regard to provinces stand at around 10 per cent. On the other hand, a simulation model based on convergence theory and on estimates of the speed of β convergence obtained by a sample group-type method indicates that the level of disparity in worker productivity between Canadian regions has been close to its steady state since the mid-1980s. We may therefore conclude that, in the absence of a structural rupture in the growth profiles of the regions, the average levels of disparity in worker productivity observed for some 10 years in Canada should persist in the medium and long term.

Two statistical facts highlighted in our study, however, temper any overoptimism that might be aroused by our first observation concerning the smooth functioning of the invisible hand and the Canadian federal system. First of all, the Canadian provinces have taken much longer than the bordering U.S. states to achieve a dispersion index with relatively low long-term equilibrium. Given the methodology used here, our study unfortunately cannot explain this curious phenomenon. Second, despite the observed convergence in worker productivity, the level of disparities in *per capita production* between Canada's regions is still twice as high as that observed between the U.S. states. This finding is not only important for economists interested in changes in regional disparities; it must also be taken into consideration by shapers of economic policy in Canada.

In Canada, especially since the Second World War, the federal government has put in place a far-reaching program of inter-regional redistribution within the context of fiscal federalism. This redistribution is effected not only by the equalization program but also by the very structure of the federal system, under which the provinces contribute to the revenues of the central government in accordance with their capacity to pay but receive grants for expenses in proportion to their population or the demand for services. In the case of unemployment insurance and the Canadian social transfer, the proportion of federal spending in relatively poor provinces even exceeds their proportion of the country's population.

Our study shows that the force of neoclassical convergence, which causes physical and human capital to accumulate more rapidly in regions where its rate of return is highest, is no longer able to diminish needs for inter-regional redistribution in Canada in the medium and long term. Since the mid-1980s, the dispersion indexes of productivity have reached a steady state notably close to that found in the bordering U.S. states for more than 50 years. The force of convergence was the main factor that brought about a considerable reduction in regional disparities in Canada since the 1960s, but its effectiveness appears to be truly exhausted.

Our study indicates that, given the nature of differences in production between Canadian regions, it is in the labour market that we shall find measures most likely to have an impact on

regional disparities in Canada. In fact, if unemployment rates are adjusted downward and participation rates are adjusted upward in Canadian regions with low productivity to approach the structure observed in the bordering U.S. states, disparities in per capita production and the need for inter-regional redistribution could be cut in half.

If we compare the situation in Canada with that in bordering regions of the United States, it appears that Canadians are motivated to remain in regions with low productivity even though they are non-participating or unemployed. This phenomenon is the result of economic policies for inter-regional redistribution such as equalization, transfers from the federal government to the provinces to fund health care, post-secondary education and welfare, and unemployment insurance. All these programs have helped regions with low productivity to acquire and maintain public infrastructure plus education, health care and social security systems that compare quite well with those of more prosperous regions, but without having to impose an excessive tax burden.

As shown by the debate between Robin Boadway and Frank Flatters, on one side, and Tom Courchene, on the other side, in the early 1980s,¹⁰ there is no consensus on the question of the repercussions of equalization, and of inter-regional redistribution in general, on economic efficiency. According to Courchene, inter-regional redistribution is inefficient in economic terms since it prevents the adjustment of factors that would result from the play of market forces. For their part, Boadway and Flatters stress that movements of workers within a federation can be inefficient in economic terms if they are caused by the existence of rents from natural resources. Canada's system of inter-regional redistribution was initiated in the 1950s with an equalization program and in the late 1960s with shared funding for the national health program. Our study clearly shows that increased inter-regional redistribution has not prevented differences in worker productivity from finally converging toward the levels observed in the bordering U.S. states. Thus the productivity of Canadians who have chosen to work in relatively poor regions has come quite close to that of workers living in more prosperous regions. In other words, equalization does not force workers to be economically inefficient. However, inter-regional redistribution has certainly motivated Canadians to remain in the poorest regions even if they cannot work there. Is that really a problem in terms of economic efficiency? It is quite difficult to say, since we do not know what people who have chosen to stay without working in regions that receive net transfers from the federal system would do if they were forced to leave those regions.

NOTES

- 1 For selective overviews of recent empirical studies, see Barro and Sala-i-Martin (1995, Chs. 11 and 12), De la Fuente (1995) and Sala-i-Martin (1995).
- 2 Canova and Marcet (1995) recently proposed an approach with certain similarities to that used here. The authors stress the importance of persisting disparities in a steady-state regime, analysing conditional convergence in European regions by means of a Bayesian procedure. Our analysis, based on the hypothesis of unconditional convergence, provides a different explanation for the long-term persistence of regional disparities.
- 3 Data on production per province and per state, used to calculate the dispersion indexes presented in Figure 2, are expressed in nominal values since we do not have production deflators for U.S. states. These data will be used later in studying decomposition of the variance. Data relative to production per province were calculated using provincial production deflators.
- 4 It should be recalled that, in calculating the standard deviation, differences are squared, thereby giving greater weight to extremes.
- 5 The appearance of a large deviation between *levels* of Canadian and U.S. unemployment rates during the second half of the 1970s is a well-known statistical fact, which many current studies seek to explain (see, e.g., Sharp, 1996). It should be stressed here that this phenomenon is in approximate agreement with the appearance of the deviation between coefficients of dispersion in regional unemployment rates for the Canadian provinces as well as the U.S. states. It might be interesting to deepen understanding of the relationship between these two phenomena in future research.
- 6 This section is a direct application of the method set forth by Coulombe and Day (1996).
- 7 Coulombe and Day (1996) used equations of the same type to assess the reliability of results obtained by sample group–type sections. Further, they compared the results of sample group–type sections with those obtained by transversal-section regressions.
- 8 Coulombe and Lee (1995) and Lee and Coulombe (1995) also use a sample group–type method; however, the longitudinal section was constructed not from annual data but rather for periods of six and seven years.
- 9 The R^2 of dynamic simulation allows us to assess the extent to which changes in σ are correctly predicted by this simulation.
- 10 See Boadway and Flatters (1982) and Courchene (1981).

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